RESTRUCTURING EMBEDDED SYSTEM DESIGN ENGINEERING STUDIES TOWARDS A PRACTICE ORIENTED APPROACH

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Abstract—This paper describes the transformation of existing theoretical based studies in embedded systems design towards a practice oriented approach. This restructuring is done in the framework of a European funded tempus project named DESIRE, with as target countries Ukraine, Georgia and Armenia.

Keywords—tempus DesIRE, embedded systems

INTRODUCTION

Many engineering and science studies in former ex-USSR countries, are based on theoretical knowledge only. The goal of the tempus DESIRE project (Development of Embedded System Courses with implementation of Innovative Virtual approaches for integration of Research, Education and Production in UA, GE, AM) is to adapt current curricula from theoretical based curricula towards a practice oriented based education. Embedded systems design and production demands a very specific, qualitative and valuable knowledge growth in the target higher education institutions (HEI) , which ensures efficient implementation of high-skilled people in the labor market. The curricula will be developed according competences needed in local and international labor market. [1] [5]

DESIRE PROJECT AIMS.

DESIRE is a European funded project in the “Joint Projects-action”. Joint projects are based on multilateral partnerships between HEIs in the EU and the partner countries. The partners can develop, modernise and disseminate new curricula, teaching methods or materials, boost a quality assurance culture, and modernise the management and governance of higher education institutions. The aim of the DESIRE project is to change the theoretical type of learning in embedded systems design engineering in the target countries to a practice-oriented competence-based approach. [2]

The most common form of computer in use today is by far the embedded controller. This controller, combined with embedded software, is referred to as an embedded system (Figure 1). These systems are built into a product for control, monitoring and communication without human intervention. There are some 30 embedded microprocessors per person in developed countries with an average of 250 million lines of code. In a new premium car 20 to 70 electronic control units can be found.

Figure 1 Typical examples of embedded systems and products containing embedded systems.

At this moment mainly in all ex-USSR, software engineers are not involved in the science-intensive production, because embedded computer systems are becoming increasingly complex to design and build. The lack of equipment and old educational technologies have resulted in courses in embedded systems being removed from the educational curricula. Main effort at present is attributed to the design of desktop based software, as this doesn't need a lot of investment. It is clear however that such a work can be done cheaper in developing countries. Embedded systems however are used in more critical domains of human life, such as medicine, automotive and aerospace applications. This poses strong demands on quality issues of the embedded hard- and software, so a skilled workforce is necessary to make this a success.

To reach these goals, practice-oriented curricula and modules in Embedded Systems Design are created. The theoretical courses will be supported by remote laboratories and dedicated hardware platforms (physical laboratories) to form the competences necessary for the labor market in Embedded Systems. The practice oriented approach will speed up collaboration between HEIs and business in target countries and ensure the availability of a high-skilled workforce.

PROJECT DESIRE METHODOLOGY.

As the aim of the project is to transform existing learning/teaching systems to a Bologna compliant form (competence based, ECTS-supported) the consortium was built to have expertise and know-how on both technical issues as well as on pedagogy. Department of technology of Thomas More university college and the Technische Hochshule Ilmenau joined effort with Constantine the philosopher university in Nitra to bring this project to a successful end.

To come to the expected objectives of the project three different processes are initiated.

The process of making new course material, the process of making a new learning environment and the process of making the new approach operational.

As a first step, the current situation of curricula on ECTS and expected competences (by the stakeholders and labor market) are investigated and reported. This first tasks are performed by the target HEI's (Figure 2). Next the reported needed competences are turned into curricula, and new course material is developed. The European partners of the project are in charge of this part. With their experiences and know-how on technology (of embedded systems) and pedagogy (of teaching engineers), they propose the new curricula and provide the necessary course materials for this. This material will be translated by the target HEI's in the local teaching language, and if necessary reworked to fit in their (accredited) curricula.

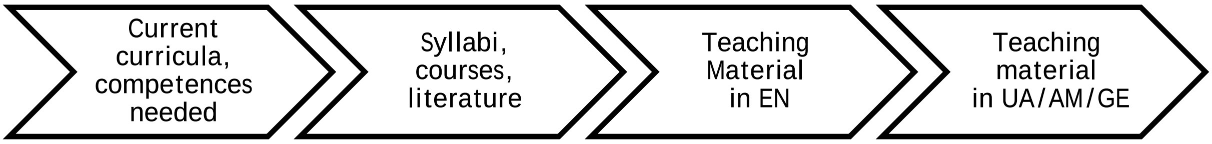

Figure 2 Process for course development.

A next phase will be the establishment of a learning environment (Figure 3), containing an LMS, a remote and a embedded systems design laboratory. For this purpose specific equipment is bought to support the courses and to support the laboratories. Equipment includes hard- and software for embedded systems, server computer and remote laboratory hardware. For the LMS-system Moodle will be used.

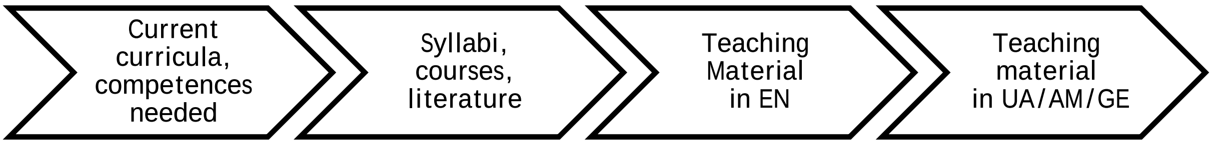

Figure 3 Process for making the new learning environment

To make the new teaching/learning environment operational, a lot of effort is spend on training teaching staff of the target HEIs (Figure 4). As such, they will have ample experience with the new system before starting to teach their own students. Retraining courses for teaching staff are organized in BE, GE and SK.

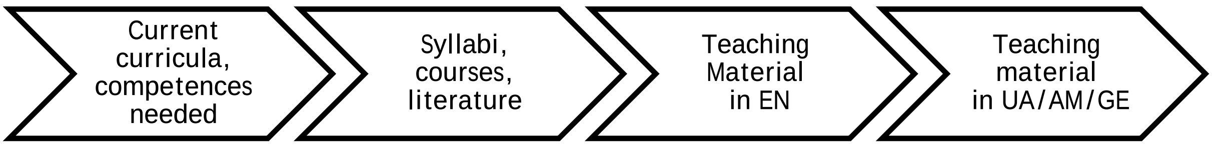

Figure 4 Process of making the new approach operational

Trainees of the retraining courses will teach their colleagues when returning to the home universities. Together with master classes in situ, a solid base is established to start with the teaching to the first pilot group of students, and to integrate all in the curricula.

All is done according to a fixed quality assurance plan, assessments on different levels and close contact with other projects. The goal is also to service local enterprises with high-skilled people, so dissemination activities are done towards this group via the university-enterprise contact group (UEGC), and also in media, via the web resources and seminars. Management of the heterogeneous project objectives and diverse partners is done via an agreed work plan, with sufficient lines of communication and the erection of different working bodies.

REMOTE LABS

In the project is provided to install in each partner HEI a remote lab. The remote lab is a visualization of a process (elevator, storage, pick-and-place robot) (Figure 5) which can be controlled either by programming with a micro-controller, by PLC, or by program coding.

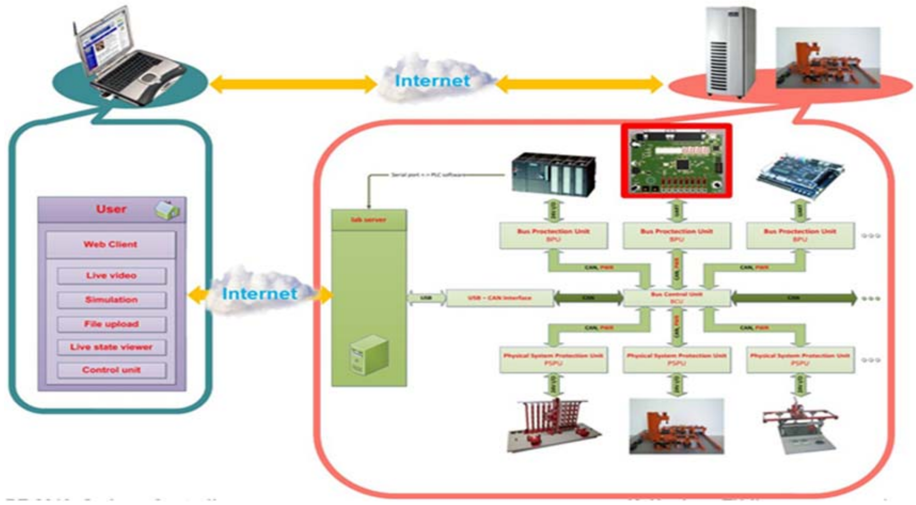

Figure 5 Remote lab setup.

As each HEI will have a remote lab, an extra goal of the project is to make all labs in the different HEIs available for students from all of the consortium. Each HEI will have its own server, so that after the project, each partner is not dependent on a server of the consortium to continue working with the infrastructure. This is very important for the sustainability of the lab infrastructure over a longer period of time, which is one of the most recognized weak points in remote experiments. [3]

Depending on the partner, the aim of working with the remote lab is different.

The technical universities will use the lab as a lab for their students to experiment on. In casu on communication, on programming, on exploitation and security issues. Implementation of the remote lab will only be successful if embedded in an appropriate learning system. A blended learning system as described in (Arras et al) [4] can be an interesting model to promote in the DESIRE-project. As all components are available (physical labs, remote labs, classroom teaching), and the necessary technical know-how in the technical universities is also readily available, this model can be implemented.

The classical universities will use the lab as an example to elaborate new teaching techniques and recommendations for using this kind of remote experiment in pedagogy. The expertise and experience of the western partners will be used as an input for this too.

CONCLUSIONS

The DESIRE-project aims at the transformation of current curricula from theoretical based curricula towards a practice oriented based education. The cooperation of a solid consortium with both technical and classical universities ensures the input of technical know-how and the expertise to transform the educational processes. After completion of the project, the skills and competences of the students in embedded systems engineering will be better in accordance with the demands of industry in the target countries.

After analysis of the current curricula, new curricula and materials will be prepared in accordance to the identified needs of the labor market. Equipment will be bought and installed. An LMS-system will be adapted and courses will be transformed from a traditional classroom teaching to a blended learning approach using the synergy of classroom teaching, physical labs and remote labs to improve skills and competences of students in embedded systems engineering design to comply to labor market demands. In the classical university partner HEIs, future teachers will be trained in exploiting possibilities of remote labs and practice oriented teaching/learning approaches. As such, teaching staff for the next generation has hands-on experience in all of these techniques.

A considerable amount of effort will be put in training teaching staff in the new teaching approaches. Retraining of staff, teach the teacher sessions and pilot teaching will ensure that the method can be adapted. As such the best possible outcomes and sustainability of the project can be ensured.

The effects in the long term perspective will depend on the willingness of all to change to the new approaches. Experiences from the western partners of the consortium at least show that these new practice-oriented approach gives students more opportunities to tune in on the labor market and to be a professional in his/her field.

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